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THE ONTARIO ENVIRONMENTAL PROTECTION INDUSTRY AND THE IMPACT OF ENVIRONMENTAL EXPENDITURES ON THE ONTARIO ECONOMY

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ABSTRACT

An overview of the current economic activity generated in Ontario as a result of environmental regulations is presented along with the prospects for economic growth of this industry and the perceived impact of free trade on these prospects. Responses from surveys of both users and suppliers of environmental protection goods and services are described. Approximately 28,000 are employed in Ontario in the generation of about $2 billion in annual sales of Ontario-produced environmental protection products and services. Growth in this industry has been strong during the past five years, and the growth prospects for the next five years seem quite favourable.

An environmental protection impact model (EPIM) is employed to project the potential impact on the Ontario economy of potential changes in environmental regulations. Offsetting the economic impact of additional costs imposed by more stringent regulations is the gain of jobs and production of goods and services in the environmental protection industry and among suppliers to this industry.

1. INTRODUCTION

In developing and defending its policies, the Ontario Ministry of the Environment is often called upon to evaluate the economic implications for the province arising from environmental regulatory changes. A comprehensive assessment of possible changes in environmental regulations requires a determination of both the likely incremental costs and the potential benefits that would result from the changes. Distributional effects are an important consideration, and care must be taken so that true economic consequences are measured.

Additional costs incurred by some segments of the economy so as to improve environmental quality will generally result in benefits for other segments. The direct benefits to others that arise through reducing emissions of pollutants into the environment are termed "externalities." While firms in the environmental protection industry can be expected to profit from more stringent regulatory standards, their gains from additional environmental protection activity constitute a "transfer" from the purchasers to the suppliers of such goods and services. Failure to account adequately for such external benefits (alternatively, reductions in external costs) or transfers of economic activity in any analysis tends to stack the deck against more stringent regulatory standards. Potential cost increases are less likely to go unnoticed.

Many of the external benefits arising from pollution abatement are quite diffuse. As a consequence of a particular environmental initiative, the economic value to most individuals of improved health (or reduced risk of disease), of additional building longevity, of reductions in aesthetic impairment, etc., may be rather low. Nevertheless, by adding up the individual gains, the total benefit to the economy may be substantial.

In other instances, individual external benefits may be substantial. More stringent abatement measures required of an upstream polluter may reduce the cost of water filtration and purification downstream. In addition, the health and aesthetic impact of pollution, among its other effects, may be substantial for those who live or work near the source. Consequently, higher costs imposed on one firm may reduce costs to other firms and households. This example could be stated just as forcefully for benefits arising from more stringent air pollution standards.

As for the transfer effects of regulatory change, additional expenditures by one Ontario firm may provide revenues to another. (The expenditures may "leak" to firms outside of the province.) Firms which provide pollution control equipment or services are likely to gain business and become more profitable as a result of the additional costs arising from the regulatory change.

Environmental regulations in Ontario are the cause of a sizeable amount of economic activity in the province through the provision of pollution control equipment, materials and services. This activity represents a transfer of economic activity from other sectors of the economy, since the need to devote investment funds to meeting environmental regulatory requirements may lower rates of return and thereby reduce industrial investment spending. A constraint on funds for capital expenditures implies that, in the short run, investment in environmental protection equipment will prevent investment in productive capacity that would otherwise take place.

The production of pollution control equipment and services generates additional activity, or spinoffs, in the economy. This comes about both from the purchases of machinery and materials by the environmental protection industry and from the consumer spending generated as the result of salary and wage payments to employees in the industry.

The focus of this paper is on the economic spinoffs, or transfers, resulting from environmental protection expenditures. The effect of control orders and regulatory changes on the environmental protection industry are relatively easy to generalize. The analysis of benefits generally must be carried out on a case by case basis.

This paper provides an overview of the environmental protection industry in Ontario. The discussion which follows is based on a recently completed study which was carried out by Woods Gordon Management Consultants (1988) for the Ministry of the Environment. This study assesses the scope and scale of environmental protection activity in Ontario and provides a model of the economic impact of such activity. It follows up work initiate in an earlier study, aimed at defining the industry, which was carried out by Institute for Research on Public Policy (1987) for the Ministry of the Environment.

The following section of this paper briefly defines the environmental protection industry and discusses the methodology used to gauge the extent of environmental protection activity in Ontario. Surveys of purchasers and suppliers of environmental protection equipment and services are described. Estimates are provided of revenues earned by various segments of the Ontario environmental protection industry and of the direct employment by this industry. Growth prospects for the sector, and the likely implications of the Free Trade Agreement on these prospects, are discussed. Finally, industry views on the role of the Ontario government in stimulating further growth are presented.

The third section of the paper describes the Environmental Protection Impact Model (EPIM) which was developed as part of the Woods Gordon study. Derived from an input-output model, the EPIM is a tool that can be used to evaluate particular effects of potential changes in environmental regulations. This model takes into account the economic transfers and spinoff effects mentioned above, but not the external benefits of abatement and control activities. The response of individual firms or sectors to potential regulatory changes in their decisions as to levels of production, employment and investment can be used as an input into the model, but this model does not generate a forecast of such responses by firms. To provide a more concrete example of both the appropriate use and the limitations of EPIM, the model is used to analyze the potential impact of a rather stylized version of a possible change in regulatory requirements affecting air pollution.

2. THE ONTARIO ENVIRONMENTAL PROTECTION INDUSTRY

2.1 Defining the Industry

Environmental protection activities are those designed to reduce or avoid emissions of materials that are detrimental to the environment. The environmental protection industry includes suppliers of equipment and services for air pollution control, wastewater treatment, solid and hazardous waste disposal and recycling, and monitoring and analyzing environmental data. The environmental protection industry definition was defined in the Woods Gordon study to include private sector Ontario manufacturers or service suppliers of specialized environmental protection goods and services, and the construction involved in equipment installation, as well as engineers and other consultants who provide advisory services on environmental protection matters.

Products which have a variety of industrial uses including environmental protection activities are included in the economic impact model but not in the discussions of the scale and trends in the environmental protection industry. Pipes, valves and wiring used to connect and install pollution control equipment are examples of such products. Also excluded from the study of the environmental protection industry are resource conservation, nuclear waste management and noise abatement activities. Nor was there any attempt to measure the direct employment or value of services provided by environmental protection personnel at government environment departments or public utilities.

2.2 Data Sources

No comprehensive data source exists for the environmental protection industry in Ontario. Most of the activity in this sector is undertaken by firms involved in a range of non-environmental manufacturing and service activities, and is

therefore incorporated into broader industry categories by statistical agencies. Data on expenditures on environmental protection (as opposed to Ontario production of environmental protection products and services) are available in an incomplete form, with public sector spending tracked more comprehensively than private spending.

It was necessary, for the purposes of the study, to undertake for the first time a significant effort at obtaining new quantitative and qualitative perspectives on this sector in Ontario. These data were obtained by four different approaches:

(1) a review of existing literature and statistical sources;
(2) interviews with 75 purchasers of environmental protection products/services;
(3) a mail survey sent to over 1,800 Ontario firms identified as possible manufacturers of goods or suppliers of services for environmental protection; and
(4) follow-up interviews with 30 suppliers of environmental protection products.

The interview samples were drawn from a wide range of purchasing industries and municipalities, and from suppliers of various products and services for air, water and solid and hazardous waste pollution control.

The literature review covered both published and unpublished reports on the environmental protection industry in Ontario, in Canada as a whole and in other countries. A very large body of literature is available on very specific aspects of environmental protection engineering and technology. The focus, however, was on the somewhat smaller group of reports on the economic aspects of the environmental protection industry and the scale of activity in various jurisdictions.

Data are also available from Statistics Canada on capital expenditures for which firms claimed accelerated capital consumption allowances under tax law provisions allowing special

treatment for water and air pollution control assets. Officials in the relevant department of Statistics Canada indicated that data obtained by this method would provide a misleading picture of actual pollution control expenditures. Similarly, officials at the Approvals Branch of Environment Ontario advised that many firms do not report project costs on their applications for certificates of approval, so that these data would seriously understate the potential expenditures.

The survey of purchasers was intended to provide an indication of the types of products and services demanded, the role that Ontario firms play in meeting the needs of these purchasers, the views of purchasers as to the future growth in their environmental protection spending, and the impact of bilateral free trade on the Ontario environmental protection industry.

In order to obtain a broad-brush view of the activity of environmental protection firms in Ontario, a large-sample mail survey of Ontario environmental protection goods and service suppliers was carried out in the spring of 1988. The purpose of the survey was to obtain an indication of the scale of the industry in the province, and employment levels, recent growth trends and future growth possibilities, and product range within the industry. In contrast to the existing work that has been directed at estimating the value of environmental protection goods and services *purchased*, the emphasis in this part of the study was on the even more difficult task of obtaining data on the nature of environmental protection industry *production* with significant Ontario content.

2.3 Supplier Survey Procedures and Responses

The list of respondents was initially compiled from a directory of environmental protection firms in Canada which was assembled by William Glenn (1987a). Over 1,700 Ontario firms were listed. Because the number of Ontario firms in the list identified as manufacturers of the air pollution control equipment appeared to be too low, firms identified as part of

this sector were added. The survey was sent to over 1,800 firms. A portion of these firms turned out to be distributors rather than manufacturers of environmental protection products, or to be selling products and services that were only tangentially or infrequently related to environmental protection applications. Consequently, the universe of domestic manufacturers of reasonably specialized environmental protection goods or service firms is judged to be on the order of 1,200 firms.

A total of 261 firms responded to this survey, a 14% rate of response. Of these, 197 indicated that they were involved in environmental protection activities in Ontario. Of this group, 164 provided sales and/or employment data. A total of 138 provided sales and employment data, 21 provided employment data but no sales data, and 5 provided sales data but no employment data. The other 33 firms supplied some data on products and growth projections, but did not report sales or employment. Some 64 firms indicated that they were not, in fact, involved in environmental protection manufacturing or services in Ontario. The list of firms with complete responses includes many of the largest firms in the Ontario environmental protection industry and a large number of small service sector firms.

The respondents to the supplier survey sold over $0.5 billion in Ontario-produced environmental protection products and services in 1987. These sales figures are generated by firms producing products and services with a high degree of Ontario content. Only 10 firms, primarily instrument manufacturers, reported less than 50% Ontario content in their Ontario-made products. This is not surprising, since services account for a significant share of the total environmental protection production in the province, and the survey excluded distributors of imported products. Since any voluntary survey will achieve only a partial response rate, the survey findings reported here provide an initial lower-bound for the scale of the industry in Ontario.

The total sales of environmental protection goods and services in the province is likely to be much higher than the figures generated in our sample of respondents. A number of other statistical sources were reviewed in an effort to obtain an understanding of the full extent of environmental protection activity in the province. Necessarily rough estimates of the annual sales volume of the Ontario environmental protection industry by major category have been prepared. Such estimates are based on these other sources, together with survey responses, a review of the list of respondents and non-respondents in light of knowledge about the leading industry participants, and discussions with over 100 industry participants. These estimates should be viewed as conservative (i.e., low) ranges for the magnitude of the various types of environmental protection activity in Ontario. They provide a useful indicator of the importance of the overall environmental protection sector to the provincial economy.

2.4 Characteristics of the Industry

As shown in Table 1 below, the size of the environmental protection industry in the province appears to be on the order of $1.5 to $2.5 billion in terms of total annual sales revenue, excluding non-specialized goods and services used in conjunction with environmental protection products.[1] Within these totals, wastewater treatment accounts for the largest share of the goods production sector, while solid and hazardous waste disposal and recycling are the largest service sector contributors. In addition to these commercially provided goods and services, all three levels of government provide a range of environmental protection services.[2]

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[1] For the purposes of determining the scale of and trends in the Ontario environmental protection industry, products which have a variety of industrial uses apart from environmental protection activities were excluded. See Section 2.1 above.

[2] The following studies give an indication of the extent to which expenditures by the three levels of government contribute to estimated industry sales revenues as reported in Table 1.

Table 1
ESTIMATED 1987 REVENUES OF THE ONTARIO ENVIRONMENTAL PROTECTION SECTOR*

Commodity	Estimated 1987 Revenues
Machinery, Equipment, Instruments, Supplies	$250 - $400 million
Recycling Services	$500 - $1,000 million
Waste Disposal and Destruction Services	$300 - $400 million
Construction Services	$350 - $500 million
Consulting Engineering and Analytical Services	$100 - $200 million
TOTAL	**$1.5 to $2.5 billion**

* Excludes services provided directly by governments

Corporate Policy and Planning (1986) reports a total value of Ontario government expenditures on environmental protection of $912 million in fiscal year 1983/84. Some, but not all, of such expenditures for 1987 would be included as environmental protection industry revenues in Table 1 above. An examination of preliminary figures for Ontario public sector expenditures on environmental protection through 1987 suggests that such expenditures account for more than 50% of industry revenues.

According to Laikin and Donnan (1987) in their study of environmental protection expenditures in Canada, over 70% of capital expenditures for environmental projects during the period from 1980 to 1984 were incurred by the public sector. Private sector figures for operating and maintenance costs related to environmental protection could not be determined. Total expenditures on environmental protection and pollution by all levels of government in Canada averaged $5.1 billion during the 1980 to 1984 period, of which $3.4 billion (67%) were public sector operating and maintenance expenditures.

The 159 firms that responded with employment data in the mail survey were responsible for the direct employment in Ontario of 5,455 person-years in their environmental protection operations. Total employment in the environmental protection industry is therefore considerably greater.

An estimate of total industry employment can be derived from the ratio of employment to shipments indicated in the survey, the typical level of construction expenditures to construction industry employment, the ratio of employment to shipments of members of the Canadian Association of Recycling Industries, and the estimate of total industry sales revenue above. Based on these factors, it is estimated that the environmental protection industry generates direct employment in Ontario of 20,000 to 36,000 full-time equivalent positions.

As indicated by Table 2 below, total Ontario employment in the environmental protection industry is comparable to that in the communications equipment, clothing and wood products industries, and ahead of such industries as metal mining. The 5,455 employees identified in our mail survey alone would put the environmental protection sector close to or ahead of such industries as Shoe Factories (7,500 employees in June, 1987), Knitting Mills (6,500), Iron Foundries (5,200), and Major Appliances (5,100).

The total number employed in all environmental protection related activities in Ontario is much larger. Federal, provincial and municipal officials involved in environmental activities and environmental engineers at large industrial plants, and at firms manufacturing pipes, wires and other basic products used in conjunction with environmental protection industry products should also be counted. Glenn (1987b) estimated that across Canada, governments employed over 50,000 individuals in environmentally-related positions. If employees of non-specialized equipment producers were included, he estimated that environmental protection employment in Canada could be as much as 150,000. Laikin and Donnan (1987) reported

that total employment directly related to environmental protection was at least 100,000 in Canada during the period from 1980 to 1984. They also indicate that total employment in environmental activities by the three levels of government was 43,000 people during this period.

Table 2
ENVIRONMENTAL PROTECTION INDUSTRY EMPLOYMENT IN ONTARIO RELATIVE TO OTHER SELECTED INDUSTRIES, 1987

Industry	Ontario Employment
Rubber and Plastic Products	48,100
Paper and Allied Industries	43,400
Furniture and Fixtures	34,800
Communications Equipment	30,000
Environmental Protection	**28,000 (est.)**
Clothing Industry	27,400
Wood Industries	27,100
Metal Mines	19,700
Pharmaceuticals and Medicines	10,300

Source: Statistics Canada (72-002) data for June, 1987 and Woods Gordon estimate

2.5 Industry Growth

The results of the mail survey indicate that sales of industry participants have been growing quite strongly since 1983, particularly for firms in the air and water pollution control sectors. Those firms reporting environmental protection sales in 1983 showed a compound annual growth rate ranging from 17% in solid and hazardous wastes to 32% in wastewater treatment over 1983-87.

It should also be remembered, however, that the Ontario economy was emerging from a recession in 1983, in which capital expenditures for all items had fallen off dramatically. Thus the reported growth rates from that period may exceed sustainable, longer term prospects. In addition, the data may themselves overstate actual total industry growth over the 1983-87 period. Evidence from the growth of public expenditures on environmental protection activities shows a somewhat more modest growth rate for their share[3] of environmental protection spending.

Both purchasers and suppliers of environmental protection products and services anticipate rapid growth in sales over the next five years. Among the suppliers who responded to the mail survey, the weighted average annual growth rate expected for the next five years (with the weights based on each firm's share of total 1987 sales) was 17% per year, more than twice the growth rate generally anticipated for nominal gross domestic product (GDP) in Ontario. While these expectations may reflect an overly optimistic assessment by individual respondents on the share of the market their firm will achieve, it appears that there is a general consensus that environmental protection will be a rapidly growing field into the 1990's.

Most of the sales increase anticipated by environmental protection suppliers are based upon their belief that environmental protection legislation will be significantly tightened in Ontario and elsewhere in Canada over the next few years. Purchasers generally appear to share this viewpoint.

The mail survey and interviews with selected industry participants suggest that strong growth opportunities exist in all three major segments of the environmental protection industry

[3] Preliminary Environment Ontario figures for the period from 1980 to 1985 suggest an average growth rate of 5.6% for Ontario public sector expenditures which flow directly to the private sector. See note [1] for a discussion of the public sector's share of total environmental protection spending.

(air, wastewater and solid and hazardous waste). Near term opportunities will include the supply of goods and services related to meeting the needs of such purchasers as Ontario Hydro and others responding to tightened provincial regulations. There are important requirements for monitoring equipment and analytical services designed to meet the new emphasis on monitoring and controlling emissions of toxic substances in low concentrations. In the longer term, solutions to the growing problems associated with solid and hazardous waste disposal could provide opportunities for recycling services and various process innovations designed to reduce waste production at the source.

2.6 International Competitiveness and the Impact of the Free Trade Agreement

Of the respondents reporting sales data, 66 firms indicated that some or all of their 1987 revenues were attributable to export sales. These firms registered total export sales of $67.6 million last year, or 13.5% of the total value they reported of environmental protection production in the province. It is not possible, however, to confirm whether or not this export share is typical for the industry, as most environmental protection commodities are included in broader export figures in Statistics Canada data.

The future of the environmental protection industry in the province will depend on the ability of firms in Ontario to compete with equipment and service suppliers from the United States, and to a lesser extent, Europe and the Far East. In the goods sector, Ontario firms already compete with imports, particularly in the fields of instrumentation and basic equipment (pumps, motors and other machinery) used in environmental protection. In the service sector, much of the activity in the province is handled by employees from local offices, regardless of whether their employer is based in Ontario, elsewhere in Canada or is a local branch of a multinational.

Study findings suggest that free trade will be modestly beneficial to the Ontario environmental protection industry,

despite the fact that existing trade barriers are higher on U.S. exports to Canada than on Canadian exports to the United States. Freight costs and custom design requirements will continue to limit the extent to which the final assembly of environmental protection products could be centralized outside the province. Ontario service sector firms are quite competitive, and could expand the export of consulting engineering and design services. In the supply of higher-technology pollution control devices, Ontario firms are competitive in certain product niches, while other such products are already largely imported.

There was a broad concern that exchange rates were at least as important as tariffs in determining Ontario's trade balance in the environmental protection sector. Many respondents suggested that their competitive position would be eroded if the Canadian dollar went much above $0.80 U.S. in the absence of other competitive-enhancing developments, such as more moderate wage rate inflation in Canada than in the United States, or improvements in the relative productivity of labour in Canada.

Some of the other factors affecting the Canadian environmental protection trade balance will not be addressed by the Free-Trade Agreement. The perceived lack of awareness among Canadian engineering consultants about Canadian supply capabilities, and the resulting frequency with which they direct business to foreign suppliers in their specifications, was mentioned by Canadian manufacturers of water treatment equipment (and other environmental protection products) as being a trade irritant. Also mentioned as a trade irritant is the "Buy America" legislation in the United States which requires that state and local projects which receive federal funding must provide a price preference for domestic suppliers over foreign bidders, and which will be allowed to continue.[4]

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[4] A similar provision in procedures for evaluating bids for public projects in Canada gives a cost advantage based on the Canadian content.

2.7 Industry Concerns and the Role of Government

In addition to the issues raised in the course of the review of the environmental protection industry's growth prospects and competitiveness, both purchasers and suppliers in the Ontario market were asked to identify areas of concern. In general, officials with the major industries which are subject to environmental regulations remain uncertain as to the ultimate implications of the trend towards tighter regulatory requirements in Ontario. Beyond the need for improved monitoring of effluents, industry engineering personnel felt little could be said until the actual abatement requirements are defined under the *Municipal/Industrial Strategy for Abatement (MISA)* and the *Clean Air Program (CAP)*.[5]

In particular, while industry officials are aware that the adoption of the Best Available Technology Economically Achievable (BATEA) will be required, what these requirements will be in practice is still unclear. If the requirements dictate no more than what is currently required in the United States, there should be no major technological difficulties. Otherwise, the prevailing view is that long lead times will be necessary in order to implement the new standards without imposing a substantial financial burden on Ontario industry.

Most suppliers felt confident that they could meet many of the technical requirements arising from the new regulatory requirements, as they expect that the ultimate regulations will not require industries and municipalities to exceed the standards already in place, if not always enforced, in the United States. Ontario, in turn is viewed as setting the stage for parallel legislation in other provinces. Many suppliers feel that industries could retrofit and clean up processes to meet legislated targets, and that this need not involve the large dollar figures which the affected industries will inevitably claim.

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[5] See Ontario Ministry of the Environment, 1987a and 1987b.

Following the American lead was thought by some to be detrimental to the environmental protection industry in Ontario. By taking the lead in regulatory requirements, if not in enforcement, the U.S. stimulates its firms to develop technologies which can then be exported. In some fields of pollution control, the U.S. is viewed as being five years ahead of Ontario. When compared with the views of purchasers, it appears that the most beneficial approach for both suppliers and purchasers involves being at the leading edge in terms of announcing future targets for environmental protection, but allowing sufficient lead times before new standards come into effect to allow for the design and development of appropriate technologies in Ontario.

Both the approvals process administered by Environment Ontario and the design specifications made by consulting engineers are perceived by environmental protection equipment suppliers to promote the use of existing U.S. technologies in Canada rather than foster the development of new environmental protection technologies in Ontario. Some firms felt that, although control orders and environmental regulations mention only end-use performance, in practice approvals are granted on the basis of meeting design requirements. An unverified perception of suppliers is that new pilot projects which are being tried in the U.S. would not be approved in Ontario.

Thus, while encouraging research on the one hand, the Ministry is viewed by suppliers as promoting the conservative use of existing technologies through its approvals process (by favouring the adoption of old technologies over experimental systems), and by lagging behind the U.S. in promulgating new regulatory requirements. A similar conclusion was reached by the Task Force on Environmental Protection Technologies (1983). Consulting engineers also promote this conservatism, according to equipment manufacturers, by specifying existing technologies and resisting innovative Ontario equipment that has not been applied elsewhere. Similarly, engineers at multinationals tend

to copy designs used in parent company plants, reinforcing the use of imported equipment.

A problem that was mentioned by a few respondents concerned the lack of attention given to Canadian content by Ontario municipalities. It was suggested that price-advantage policies comparable to the "Buy America" program in the United States would help would help domestic manufacturers and would bring tendering practices of Ontario municipalities in line with those of the United States and other countries.[6] Others suggested that municipalities should be given less latitude by the Ministry, since what they view as lax standards have sometimes led municipalities to adopt low-cost, but ineffective equipment to the detriment of suppliers of more effective, but more expensive, technologies.

There is considerable government involvement in many of the "high tech" aspects of solid and hazardous waste disposal.[7] Individual departments within the federal government are responsible for environmental assessment and maintenance of federal lands, with Environment Canada having the mandate to establish general guidelines and standards. Provincial governments are responsible for provincial lands, and each province is establishing guidelines and legislation. The

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[6] Ontario municipalities are, in fact, subject to provincial guidelines that provide a 10% price advantage based on the Canadian content of tenders for the purpose of comparing bids. While there may be municipalities that fail to carry out these guidelines on all bids, the problem may be primarily one of perceptions. The municipality of Metropolitan Toronto, for example, indicates that it has adhered to these guidelines on all tenders during the past ten years.

[7] Possible examples include government actions which encourage or regulate new technology for the disposal of toxic waste. Capability for the destruction of PCB's and other highly toxic wastes has been developed in Ontario. The expertise exists in the province to manufacture plasma arc furnaces capable of achieving the temperature and resident time necessary to burn and break up organic chemicals. See Woods Gordon (1988), page 58.

environmental assessment personnel and chemists who were consulted felt that it was very difficult to "nail down" the provincial ministries regarding what are and are not acceptable technologies and procedures in the area of hazardous waste disposal. The provincial ministries, on the other hand, have to receive public input into the establishment of standards and guidelines, and this is proving to be a time consuming process. As a result, highly feared chemicals such as PCB's have yet to be destroyed in Canada and they continue to accumulate and be stored on a temporary basis.

In terms of direct government assistance to the environmental protection industry, participants felt that this was of secondary importance to the timely development and enforcement of environmental legislation. Grants and research funding cannot have the impact that will be produced by environmental protection legislation, by tougher fines placed on violators, and by ensuring that enforcement is not a cyclical phenomenon that is neglected each time there is a business slowdown. However, a number of firms had already participated in existing federal and provincial programs for research and development, and there was a fairly broad-based support for a greater Ontario government role in the development of new environmental protection goods and services in the province.

According to one respondent, a successful Ontario manufacturer of instrumentation, the Trade Export Fund (of the Ministry of Industry, Trade and Technology), the Export Manager for Hire program, and the College Intern program were all very useful and of great value. Others cited the federal government's IRAP program as being particularly effective. However, these programs were felt to be small relative to the kind of push to the industry provided by the American Superfund program.

Research and development assistance appears to be more of a concern in select, high technology components of the environmental protection industry. Most of the foreign-owned companies contacted have very little research and development

capability in Ontario, though occasional product improvements are not unusual. Coupled with the absence of a mandate to export for these branch plants, this feature of branch plant operations in the environmental protection sectors is thought to be a factor limiting the potential success of government policies designed to promote Ontario exports from these multinationals. By taking the lead in developing environmental standards and regulations, the government might be in a better position to use other incentives to encourage multinationals to undertake research and product development in Ontario, rather than following the lead of their parent companies who have already reacted to earlier U.S. regulations. The export performance of domestically-based firms might also be similarly enhanced.

3. THE IMPACT OF ENVIRONMENTAL PROTECTION EXPENDITURES ON THE ONTARIO ECONOMY

3.1 Characteristics of the Environmental Protection Impact Model

The Environmental Protection Impact Model (EPIM) is a tool developed for the Ministry of the Environment to help derive estimates of the economic impact of potential changes in environmental regulations. The impacts are in the form of jobs and income generated in Ontario through the supply of environmental protection products, both directly and indirectly through the effect of the resulting spinoffs. The economic impact of environmental protection activities and the direct benefits of an improved environment resulting from tighter regulations can be weighed against their estimated economic costs to the province.

The estimates obtained using the EPIM should be viewed as rough approximations for the actual economic impacts of environmental protection spending from regulatory change. The actual required expenditures can only be approximated before the regulation comes into force. The spinoff effects captured in this model, or any other, are approximations of those which would actually take place. Finally, as noted in the introduction, the

response of individual firms to regulatory change in their choices of production, employment and investment levels must be determined exogenously, and the external benefits to other firms are ignored by the EPIM.

The EPIM is based on multipliers derived from Statistics Canada's *Interprovincial Input-Output Model*. Multipliers are coefficients which relate expenditures on one commodity to their total impact on the economy. Input-output modelling is a special case of general equilibrium analysis which attempts to model all of the linkages between the various sectors of the economy. Changes in the output of one commodity will, in a general equilibrium model, result in changes in demand for labour and for the various commodities that serve as inputs into the production of that commodity. The resulting changes in input use require further adjustment in the levels of labour and other commodities used in their production.

In input-output analysis, the relationship between the various commodities is assumed to be linear and fixed. Production of each product is assumed to require a constant mix of inputs from the various sectors of the economy, regardless of the level of output. Conclusions derived from input-output models are reliable so long as relatively small changes in output and relatively short time periods are considered. Input-output models, because of their linearity, may be more sensitive to such caveats than more general models to which they also apply.

It is also assumed that there is unemployment and excess productive capacity in the economy, so that suitable resources exist to meet any increase in demand. The possibility of labour shortages or capacity constraints is excluded in this type of model. As is the case with more general models of this type, the predictions of an input-output model would be suspect when various sectors are operating at close to capacity.

The EPIM has separate multipliers for 92 different classes of commodities. The model is able to estimate the economic

impact in Ontario of each dollar spent on any of the 92 commodity classes, including the spinoff effects on labour and required inputs. There are separate multipliers to capture the effect of changes in direct employment. For expenditures that are known to be made in Ontario, the commodity classes are consolidated into 43 groups.[8] Multipliers are higher for commodities for which Ontario production constitutes a greater share.

Use of the model requires estimates of the incremental expenditure, by commodity class, generated by the proposed regulatory change. In addition to the change in environmental protection expenditures resulting from the regulatory change, a complete analysis would include the differences in investment and in input requirements which constitute firms' responses to the new regulations. The EPIM translates these estimates, broken down into repeat and one-time expenditures, into estimates of permanent and one-time employment and GDP impacts.

To the extent that multipliers differ for the various commodities, more accurate estimates of economic impact can be achieved when environmental protection expenditures are allocated accurately among the commodity classes. This exercise can be quite challenging. Firms often have substantial latitude in their choice of abatement measures to achieve regulatory objectives. In addition, abatement expenditures usually involve allocations to several commodity classes.

While care should be taken in classifying expenditures, some experience with the model indicates that, in general, choices made between similar categories will not appreciably alter the order of magnitude of the impact estimates. The EPIM is intended

[8] See chapter 7 of Woods Gordon Management Consultants (1988), for a list of commodity classes used in the model and examples of environmental protection goods and services in various of the classes. This source also describes the EPIM in greater detail than is possible in this paper. Appendix II of Woods Gordon provides a complete printout of an illustrative example run through the EPIM.

to provide an indication of the range of possible employment and income consequences of a project or regulatory change rather than a precise point estimate.

3.2 Use of the Model: An Example

To give a better idea of the appropriate use of the EPIM, the model was applied to provide the economic impacts resulting from costs estimates of a possible regulatory change. The Ontario Ministry of the Environment (1987b) has proposed several important revisions to Regulation 308 (General Air Pollution) of the Environmental Protection Act. If adopted, direct emission limits would be imposed on all air pollution sources of an appreciable size, and the existing air quality criteria would be replaced by ambient air standards. Other changes from the existing regulation were also proposed.

To assist in deliberations about the proposed revisions to Regulation 308, the Ministry commissioned an economic assessment to examine the likely benefits, costs and consequences of implementing the proposals. The actual benefits, costs and consequences of the proposed revisions will depend on what emissions standards are actually put into place. Approximations of possible standards were used to derive a variety of implementation scenarios. Several of these scenarios are evaluated in the economic assessment so as to provide a range of options that will be useful for deciding how best to implement the proposed revisions. The details and results of the economic assessment are to be reported in VHB Research and Consulting Inc. (forthcoming).

Because the proposed revisions to Regulation 308 are still in the discussion stage, the anticipated benefits and costs that would result are as yet uncertain. Taking projected expenditures for additional monitoring and abatement for one of the scenarios studied in the economic assessment as inputs, the EPIM is used to derive the impact of this aspect of the proposed revisions on the Ontario economy. That a particular scenario is analyzed in this paper rather than any of the others does not in any way

suggest that it is preferred by Environment Ontario or that it dominates the others on a basis of the economic assessment. This exercise is intended only as an illustration of the EPIM.

The economic assessment describes a variety of abatement and monitoring technologies that are likely to be employed in response to implementation of the proposed revisions to Regulation 308. Among the types of air pollution control equipment now in use in Ontario and for which demand is likely to increase are the following:

Baghouses - systems to trap particulate matter in which the emissions are forced through a chamber containing cloth bags. Among their components are valves, iron walls, temperature sensors, and flow measurement devices.

Cyclones - a type of inertial separator which causes heavier particles to settle by swirling gases using fans or a spinner. Inertial separators are used primarily for collecting medium- and coarse-sized particulate matter.

Electrostatic Precipitators - devices designed to collect particulate matter out of gases through the use of electrically-charged rods. They contain some electronic components, but are not a very high-technology product.

Incinerators (Afterburners) - devices used to burn off waste gases including combustible aerosols, particulates, gases or vapour emissions. (Incinerators used to burn solid or liquid waste are *users* of air pollution control equipment.)

Scrubbers (Gas absorption) - systems which remove one or more constituents from a gas stream by dissolving them in a selective liquid solvent. They are composed of spray nozzles, jets of water, lime, a steel box, valves, a water pump, flaps, temperature controls and pressure sensor instrumentation, or variations on the above. They are not very high-technology products.

Additional monitoring equipment will also be required to ensure that the mandated abatement levels are achieved. Several types of monitoring needs will have to be satisfied, as indicated below:

Continuous Emission Monitoring Systems (CEMS) - devices that give a series of on-line measurements of the concentration of specific components that may be contained in a gaseous effluent. The particular definition of "continuous" (that is, the frequency of sampling) influences the characteristics of the type of monitor that must be employed in any given circumstances. Such devices will be used as compliance monitors.

Stack Sampling - a variety of techniques used to measure the emissions, including rate and concentration, from a stationary source. Systems are available for emissions of particulate matter, organic compounds, sulphur dioxide, nitrogen oxides, total hydrocarbons and other pollutants.

Ambient Air Quality Monitoring - required to ensure that ambient air standards which would come into effect under the proposed revisions to Regulation 308. A variety of techniques must be developed to cover the range of contaminants subject to regulation, and some existing techniques may require modification.

For one of the scenarios that was evaluated, the economic assessment concluded that the additional capital expenditures that would result for each of the first five years following implementation of the proposed revisions amount to $780 million. Additional operating and maintenance expenditures resulting from the proposed revisions would increase from a third to a half the level of capital expenditures during the five year period. The EPIM is used to evaluate the macroeconomic impact of the additional environmental protection expenditure resulting from

the proposed revisions to Regulation 308 for one of the first years following their implementation based on this scenario.

The analysis is complicated by two factors. First, the work completed to date on the economic assessment does not spell out how all the predicted expenditures are allocated to the various types of abatement and monitoring equipment. Second, there is as yet no information on how to allocate expenditures on the various types of equipment or their related operating and maintenance costs to the different commodity classes.

Total one-time capital expenditures of $780 million and total annual operating and maintenance expenditures of $285 million are used as input for the EPIM. Based on descriptions of the various pollution control devices likely to be used, the total one-time and annual expenditures are allocated arbitrarily to various commodity classes. Likewise, expenditures for products or services from an Ontario supplier are distinguished arbitrarily from those of unknown origin. The breakdown of total expenditures by commodity class and by origin of supplier is provided in Table 3.

The first section of Table 3 lists the commodity classes for which expenditures are assumed to be made on goods and services for which the origin of supply is uncertain. The second section lists the industries in Ontario which are assumed to supply the required environmental protection goods and services of known Ontario origin. The third section provides for direct employment of additional Ontario workers to meet the additional demands imposed by the proposed revisions.

The additional capital expenditures are indicated in the first column, while the additional operating and maintenance expenditures are provided in column two. The total GDP impact in column three of the Table is determined from the total expenditures for each commodity class and the GDP multiplier which corresponds to that class. The total employment impact of the expenditures, provided in column four, is derived from the

Table 3
EXAMPLE OF ECONOMIC IMPACT PROJECTIONS FROM THE EPIM

COMMODITY / INDUSTRY	ONE-TIME EXPENDITURE ($)	ANNUAL EXPENDITURE ($)	TOTAL GDP IMPACT ($)	TOTAL EMPLOYMENT IMPACT (person-years)
(1) IMPACT OF PURCHASE OF ENVIRONMENTAL PROTECTION GOODS/SERVICES (OF UNSPECIFIED ORIGIN)				
33. Other Textile Products	10,000,000	10,000,000	8,080,000	238
50. Boilers, Tanks and Plates	70,000,000	10,000,000	47,600,000	1,150
51. Fabricated Structural Metal Products	40,000,000	10,000,000	38,500,000	866
52. Other Metal Fabricated Products	50,000,000	10,000,000	35,760,000	840
54. Other Industrial Machinery	70,000,000	15,000,000	17,255,000	413
64. Industrial Chemicals		60,000,000	19,020,000	422
67. Other Chemical Products		60,000,000	26,820,000	596
68. Scientific Equipment	150,000,000	15,000,000	16,995,000	423
84. Business Services	25,000,000		19,125,000	665
Sub-total	415,000,000	190,000,000	229,155,000	5,612
(2) IMPACT OF PURCHASING GOODS/SERVICES FROM AN ONTARIO MANUFACTURING OR SERVICE FIRM				
20. Metal Fabricating (46-50)	70,000,000	15,000,000	72,360,000	2,088
28. Construction (70-73)	270,000,000	25,000,000	293,265,000	7,693
31. Electric Power, Gas (78,79)		20,000,000	14,085,000	282
38. Services to Business (44,84)	25,000,000	25,000,000	67,240,000	2,434
Sub-total	365,000,000	85,000,000	446,950,000	12,497
(3) IMPACT OF IN-HOUSE ENVIRONMENTAL PROTECTION EMPLOYMENT				
Services to Business		10,000,000	9,160,000	1,134
OVERALL TOTAL	**780,000,000**	**285,000,000**	**685,265,000**	**19,243**

total expenditures in the commodity class and from the employment multiplier corresponding to that class.

Environmental protection expenditures on goods and services of known Ontario are seen in Table 3 to have a greater impact on Ontario GDP and employment, as stated above, than in the case where the origin of goods and services supplied is unknown. Sensitivity analysis could be carried out to assess the impact on Ontario employment and GDP of a change in the proportion of goods and services known to be of Ontario origin as well as on the impact of reallocations of expenditures among the commodity classes. Because the initial allocation of expenditures is arbitrary, it was decided that such sensitivity analysis would not be particularly instructive for this exercise.

The overall total impact on Ontario GDP and employment, presented in Table 3, of the additional environmental protection expenditures suggests that a significant share of such expenditures would be retained in Ontario. It must be emphasized that the results presented here made no attempt to determine the extent to which firms' investment projects or output levels would be curtailed as a result of implementation of the proposed revisions to Regulation 308, thereby offsetting some of the impact of the additional expenditures. Neither was any consideration given here to the external benefits that would arise from abatement activities.

This work was not intended to provide a complete analysis of the economic impact of the proposed revisions to Regulation 308, but rather to indicate how the EPIM can be used as a tool in the analysis of new programs. As such, it appears that this model is able to provide a rough idea of the macroeconomic impact of new programs. However, additional work is necessary to make it easier to apply. The need for consideration of possibly offsetting factors, such as changes in firms' desired investment, production and employment levels, dictates that a good deal of thought must accompany the use of the EPIM if it is to be the primary tool for assessing regulatory changes or new programs.

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